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The Edison MAZDA Lamp for Motion-picture Projection

Information compiled by
H. F. BARNES
Lighting Service Department

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FRANKLIN INSTITUTE
PHILADELPHIA

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For information regarding MAZDA lamps and lighting questions, refer to the nearest sales office as listed on the last page of this bulletin.

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FRANKLIN INSTITUTE
PHILADELPHIA

The Edison Mazda Lamp For Motion-picture Projection

Information Compiled By H. F. Barnes
Lighting Service Department

History of the Art

The coming of the MAZDA lamp for projection purposes means to the motion-picture field what the new, light six- or eight-cylinder high-efficient motor meant to the automobile industry. The MAZDA lamp itself, of course, is not new; but its successful application to projection is quite recent.

The carbon arc came into existence about 1800 and has, until recently, where electric current was available, held the field as a light source for projection.

In 1870, an experimenter named Heyl, arranged a series of photographic transparencies on the outer edges of a disk, and rotated it in front of the lens of a magic lantern. It was just as if a strip of film had been pasted around the edges of the revolving shutter that is used with the present motion-picture projector. In order to prevent blur, when changing from one picture to another, a two-wing shutter was used. Heyl's scheme was the forerunner of the present-day motion-picture projector.

In 1887, Rev. Hannibal Goodwin filed application for patent on continuous strip of photographic film, similar tothat used at present. In 1889, Thomas A. Edison perfected the first modern high-speed motion-picture camera. Following this, Edison devoted much of his time to the projector mechanism. The taking and projecting of successive photographs thus made practical the development of the art that today furnishes instruction and amusement for millions.

Advantages

Many of the same advantages that have led to the present world-wide use of the MAZDA lamps for home, industrial and street lighting, make the MAZDA projection lamp desirable. Ease, simplicity and economy of operation, as compared with other illuminants, are among its chief characteristics.

The advantages of the MAZDA lamp as regards projection are becoming well known. It gives a clear, soft light; makes operating conditions vastly more healthful; produces a better quality of pictures; and costs far less to run, in most cases, than the arc. A popular misconception, however, places the operation of the MAZDA lamp in its simplicity next to that of filling a fountain-pen. Nevertheless, in focusing the MAZDA lamp, with its somewhat smaller light source, the experienced projectionist's knowledge will stand him in good stead.

The Development of the Mazda Lamp

Thomas A. Edison made his first successful electric incandescent lamp on October 21, 1879. The filament was made of paper—a carbon filament. It was not until slightly over a decade ago, however, that the tungsten filament was brought out, and not until a coiled concentrated filament operating in a gas-filled bulb was introduced, that the beginning of exhaustive experimentation to produce a MAZDA lamp for projection was begun.

Lamps of wattage from 20 to 2000, and operating at amperages ranging from 1 to 100, have been tested out.

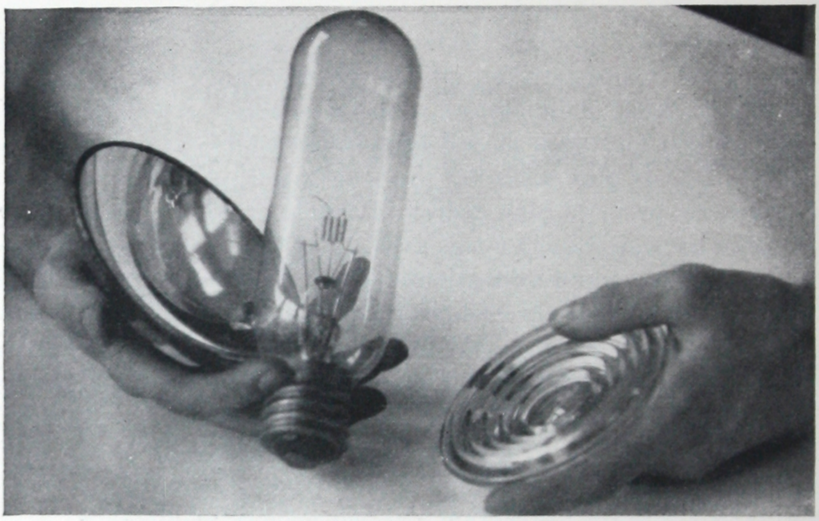

FIG. 1

The Three New Elements Necessary in Changing over to MAZDA projection: Mirror, Lamp and Condenser

Many types, sizes and shapes of filament have been made and tried. Several different shaped bulbs have been adopted from time to time. The earlier bulbs were a combination of a round and a tubular bulb, the round or bulging part being thought necessary to keep the intense heat from softening the glass. Later, a hard or lime glass was used, which enabled the filament to be put into a tubular bulb, with only a little over an inch separation between it and the side of the bulb.

The research and development work in the laboratories has been supplemented by many actual commercial installations. The lamp performance and screen results have been closely watched, so that the new Edison MAZDA lamp embodies the results of both theoretical and practical investigation.

The Mazda Lamp for Motion-picture Projection

The filament of this lamp is enclosed in a tubular bulb of hard glass, 9½ in. long from base to tip, and 2½ in. in diameter(1). The long tubular bulb is used for two reasons—first, to enable the filament to be brought close to the condenser, and thus utilize more light; and second, to reduce light absorption from blackening. When a filament is heated, and especially at very high temperatures, it continually gives off vapor, which, coming in contact with the relatively cooler surface of the glass, may form a black deposit. The farther away from the filament this cooling and deposit is allowed to take place, the less is the likelihood of the light being absorbed through blackening. Further, the long bulb helps to get rid of or dissipate the heat.

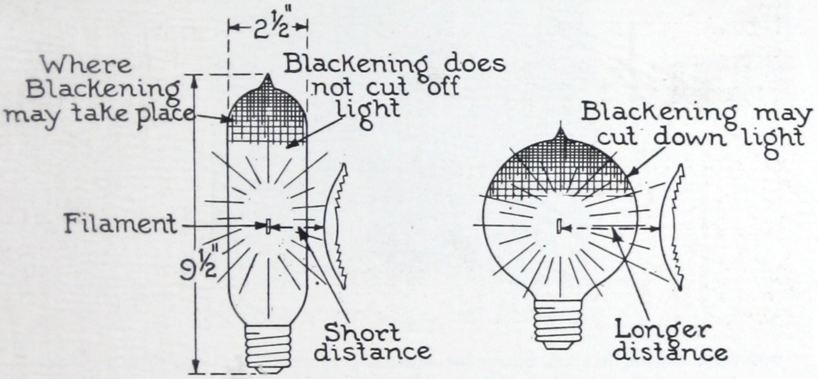
2½"
Where Blackening may take place
Blackening does not cut off light
Filament
9½"
Short distance
Blackening may cut down light
Longer distance

FIG. 2
Tubular Versus Round Bulb Showing How Much Closer the Tubular Bulb can be Put to the Condenser than the Round One; also illustrating the relative effect of blackening on the two bulbs

The filament, instead of a straight piece of tungsten wire, as in an ordinary vacuum lamp, is wound in a spiral or helical form. Many people call the filament "four little springs." In the making of the filament the wire is actually wound as closely as possible on a long thin rod, or, as it is termed in the factory, a "mandrel," much in the same manner as a person winds a piece of string around his finger. The mandrel is then taken out, and the wire bent into position.

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1. The bulb in use with the higher wattage motion-picture lamps is known as a T-20, which signifies that the bulb is a tubular bulb twenty eighths of an inch in diameter.

While the spiral or spring of wire itself is only 1¾ in. long and occupies, when bent into four parallel coils, a space of $\frac{4}{10}$ in. square, the wire itself when stretched out is almost 12 in. in length. Thus, by coiling a long piece of wire, we are able to concentrate the light within a small area.

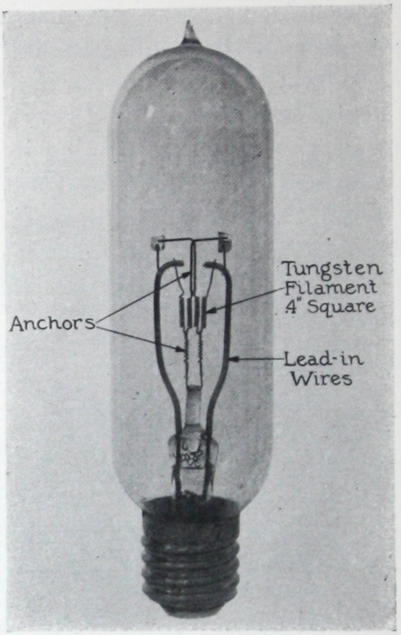

FIG. 3

900-watt Edison MAZDA Lamp for Motion-picture Projection, showing nove features of construction

As will be shown later, this $\frac{4}{10}$ in. square is the "useful area," and practically, only light from this area can be used in projecting the picture. Thus, it is desirable to crowd the maximum amount of light into these dimensions. This, of course, means making the filament as brilliant as possible, and putting individual loops or coils as close together as practicable.

The brilliancy of the filament depends upon how hot it is run. The temperature at which a filament can be run depends, to a certain degree, upon its diameter. It is obvious that a piece of wire the size of your finger can be run much hotter without danger of burning out than one the size of a hair. A thick, hot wire means a high amperage.

Putting the filament close together necessitates low voltage. Two wires carrying 100 volts, for instance, could come much closer together without danger of the current jumping than two such wires carrying 1000 volts (2).

The lamp that has been developed for use in commercial motion-picture theaters, operates at 30 volts, 30 amperes (3) a 900-watt lamp (4), and appears to be the limit in the present design. Experimental and commercial lamps of higher wattages have been found to deliver but very little more effective light on the screen, with our present means of directing, controlling and utilizing the light.

The filament is now near to the melting point of tungsten and hence the brilliancy is almost at a maximum (5).

Since the lamp filament is running so hot, it follows that forcing more than 30 amperes through the filament will be extremely harmful to the lamp.

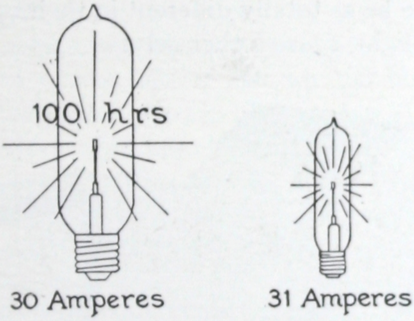

FIG. 4
The Shortening of the Life of a Lamp by Being Run Over Amperage is shown here graphically

The first two or three times a lamp is run over amperage, no visible result is noted. Consequently, many projectionists think that no harm has been done to the lamp.

2. The ability of a wire to carry amperage is in proportion to its thickness and, for a given size wire the voltage, and hence the wattage, is in proportion to its length.

The lamp with a long thin hair-like filament, such as is found in the ordinary lamp used in the home, is, due to the filament length, a lamp of high voltage and, due to the fineness of the filament, necessarily of low amperage.

3. Ordinary lamps, such as are used in the house or for industrial work, are rated in volts—i.e., we buy 110 or 115-volt lamps of so many watts. Motion-picture lamps, however, while rated in volts, are also rated in amperes.

With filaments run at such a high temperature, as are these, the amperage is the important thing.

4. Watts equals volts times amperes.

5. The filament at present is running slightly over 3300 deg. Centigrade. The melting point of tungsten is in the neighborhood of 3600 deg. Centigrade.

The lamps are rated, when run at exactly 30 amperes, to give an average life of 100 hours. Running the lamps above rated amperage gives the following approximate results:

30 amperes	100 hours
31 amperes	50 hours
32 amperes	20 hours
33 amperes	12 hours

Naturally, the increased amperage will give increased light, but not enough to compensate for the decrease in the life of the lamp.

The Optical System and Its Development

When the problem of Mazda projection arose, the first trials were naturally made with the then present arc equipment. It soon became apparent, however, that the Mazda lamp and the carbon arc were to be as totally different in their method of application, as were the light sources themselves.

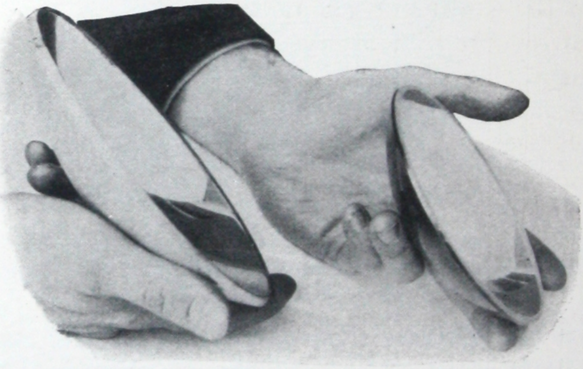

Fig. 5

Mirrors of 7 in. and 5 in. Diameter

With the Mazda lamp, light is emitted in practically all directions, in much the same manner as water comes out of a common lawn sprinkler; as much light is emitted away from the condenser as toward it, so in order to utilize economically, the greatest per cent of light from the new light source, a special optical system was developed.

The first thought, therefore, was to conserve the light thrown out toward the back by putting a mirror behind the lamp, redirecting the light toward the condenser, and subsequently on the film. A spherical mirror was chosen. Different diameters and different radii of mirrors are used. The two in most common use are 7½ in. in diameter and of 5 in. radius (6), and 5 in. diameter and 3⅜ in. radius.

If we had taken a hollow glass ball, silvered it on the outside so that the silvering reflected toward the inside of the ball, and then cut off a section of the ball, the section cut off would be our spherical mirror.

The mirror functions, when placed at the correct distance back of the filament (a distance equal to its radius), to throw an inverted image (7) of the filament near the filament itself. The filament is a series of spaced coils; so it is possible, with a little adjusting, to so arrange the image of the filament that it will fall directly between the coils, filling up the spaces.

If we might compare the filament itself to a section of a picket fence, the addition of the mirror fills up the holes between the pickets and changes it to a practically solid board fence, thus producing a fairly uniform light source.

The image thrown by the mirror should fit into the actual filament, in much the same manner that it is possible to fit the four fingers of the right hand into the four fingers of the left.

If the mirror itself were a perfect reflector, the image would be of the same brightness as the filament; but, as even the best mirrors absorb a certain portion of the light, the image is not quite as brilliant as the actual filament.

The mirror will add from 50 per cent to 75 per cent to the light on the screen obtained with the use of the lamp alone. To obtain this increase, the mirror must be adjusted properly, but, when once set, should require no further attention, beyond cleaning. Cleaning, it might be mentioned, is of the utmost importance. A very slight film of dust will practically cut the usefulness of the reflector in two.

6. Technically the term "radius" is called O.R.C., meaning outside radius of curvature. As the glass has a certain thickness, we must specify that it is the outside and not the inside surface of the glass that is used. The silvering is on the outside surface of the glass, although it reflects through the glass toward the inside of the original sphere.

7. An ordinary mirror, such as we have on our dresser at home, does not throw an inverted image, but a spherical mirror; in other words, a concave mirror throws back an image which is upside down, in much the same way that a lens inverts an image.

The importance of correct adjustment is shown from actual measurements, by the following table:

	Light on Screen
Mirror properly set	100%
Mirror ⅛ in. too far to one side	78%
Mirror ⅛ in. too far to front	85%
Mirror ⅛ in. too high or low	73%

The condensers in use with the arc system, when employed with MAZDA projection, were found to be unsuitable. First, they were of too long a focus. If the focus could be shortened, i.e., the lamp brought nearer the face of the condenser, more light would be picked up. Second, the image of the arc, as focused on the aperture plate with plano condensers, functions well in putting a uniform picture on the screen. With the MAZDA lamp, however, the filament and its mirror image are not uniform enough in brilliancy to allow it being focused in this manner; so some scheme had to be devised which would break up these images sufficiently to secure a uniform screen illumination.

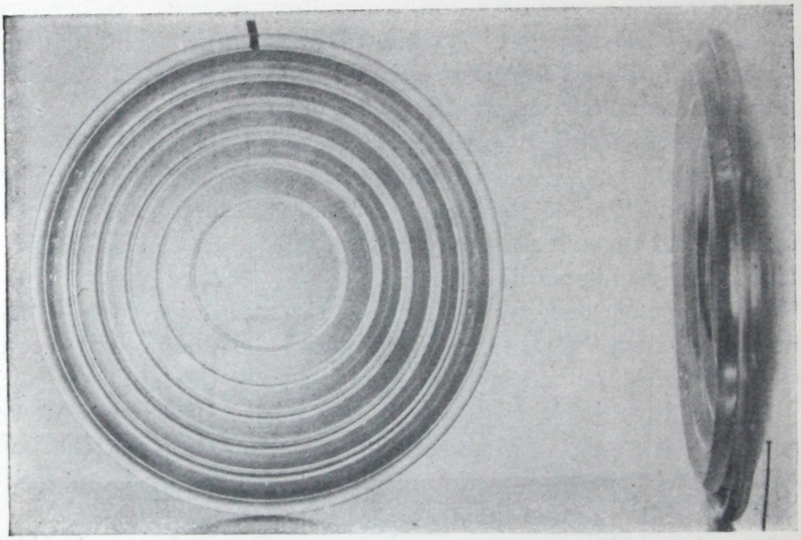

FIG. 6

Two Views of the New Prismatic Condenser

The projection lens picks up any image which is at or near the aperture plate and reproduces it on the screen. Hence, if the light at the aperture plate is uniform, the light on the screen will be likewise. However, if the light is uneven at the aperture plate, the screen itself may be streaked.

The prismatic or corrugated (8) condenser fulfills these requirements. Only one condenser is used, instead of two, as with the arc (9). As contrasted with the comparatively long focus of plano condensers, the back focus of the prismatic, i.e., the focus on the light sides, is 2½ in., thus bringing the light source much nearer and increasing the amount of light picked up.

Naturally, the shorter we can make the focus of our condenser, the more light will be picked up. For instance, if we had a stream of water issuing from the nozzle of a hose in the form of a broad spray, and we attempted to catch a portion of this water in a bucket, the closer we place the bucket to the nozzle the more water would be collected.

It is the same with light and a condenser. Light issuing from a filament is analagous to the water coming from the nozzle of the hose. The condenser might be likened to the bucket, and it catches the rays of light, as the bucket catches the water.

The corrugations or rings on the surface of the condenser help to break up the filament image, thus insuring an even screen. Where plano condensers are used for projection with a MAZDA lamp, the filament itself must be thrown out of focus and fairly even screen illumination is thus secured by the blurring of the image.

On the other hand, with stereopticon projection a set of plano condensers must be used, and hence two sets of condensers are supplied—the corrugated for motion-picture work, and plano condensers for stereopticon projection. With stereopticon projection, the projection lens is designed to pick up any image from a point directly in front of the condensing lens itself, so that if the condensing lens is perfectly clear, as the plano lens for example, the light on the screen will be uniform. Where an attempt is made, however, to use a prismatic lens for stereopticon projection, the corrugations or rings of the condenser itself will be noticed upon the screen.

The projection lens used with motion pictures, however, focuses not upon the condenser itself, but upon the aperture. As the distance between the aperture and condenser is comparatively great, the corrugated condenser is more than enough out of focus. Its corrugations, therefore, do not show on the screen, but, on the other hand, help to even up the screen illumination.

8. So-called on account of the concentric rings or corrugations on its concave face.

9. Each time a condenser is introduced in the light beam, there is at least 8 per cent loss in the light, due to reflection from the surfaces of the glass itself.

The prismatic condenser is 4$\frac{7}{16}$ in. in diameter, and 2½ in. focus on the light-source side. It can be placed from 6½ in. to 8 in. away from the aperture. The smooth or convex side faces the lamp, and the corrugated or concave side is placed toward the film.

It has been determined, from many experiments, that the prismatic condenser will "pick up" light from an area approximately $^{4}/_{10}$ of an inch in diameter—a circular area.

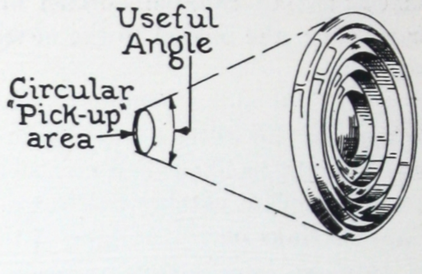

Fig. 7

Showing "Pick Up" Area and Useful Angle of Light

In other words, at a place exactly 2½ in. back from the condenser, there is a circular area $^{4}/_{10}$ of an inch in diameter, from which light will be collected by the condenser and passed through the aperture plate, and finally through the projection lens onto the screen. In order to cover a circle $^{4}/_{10}$ of an inch in diameter, it is necessary to make the filament $^{4}/_{10}$ of an inch square.

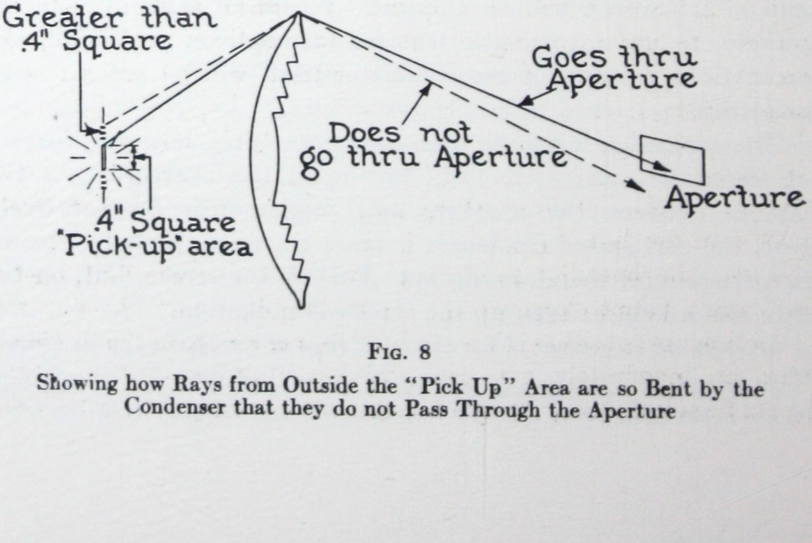

Fig. 8

Showing how Rays from Outside the "Pick Up" Area are so Bent by the Condenser that they do not Pass Through the Aperture

Light rays from any filament outside this area, while striking the condenser, will be bent in such a way that they will not pass through the aperture, and consequently are of no value in projecting the picture.

Another point; the angle between lines drawn from the filament to the edges of the condenser constitutes the useful angle. The light that is shot outside of this angle does not fall on the condenser, and hence cannot be utilized.

Thus, also, the mirror, which is placed behind the lamp to collect the rays shot in that direction, should be large enough in diameter to pick up this angle of light, as described above, and reflect it back.

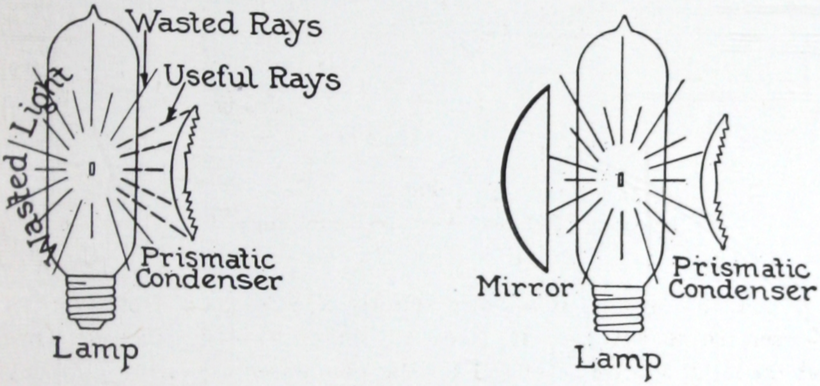

FIG. 9
Illustrating how the Mirror Utilizes a Portion of the Light which would Otherwise be Wasted, by Redirecting it Toward the Condenser

Even though the mirror is made to cover more than this "useful angle," and even though it does reflect a larger angle of light, the amount of light in excess of this useful angle will not strike the condenser. It will be passed to the outside of the condenser and, consequently, cannot be called useful light.

Housings

With MAZDA lamp projection, several new ideas must be incorporated in the housings.

First, the housings must have sufficient ventilation to insure the lamp against overheating. Overheating of the MAZDA lamp is a serious proposition. The bulb, which is made of glass, cannot stand an indefinitely high temperature, and the housing chosen should be scientifically designed to provide for adequate ventilation.

Sufficient ventilation also keeps the mirror cool. It might be noted here that mirrors will, as they are continually used, depreciate in reflecting value. The rate of depreciation is dependent, to a large extent, upon the temperature of the mirror. A large mirror, therefore, while not reflecting any more light than a smaller one will run cooler and stand up better in service. When proper ventilation, however, is supplied, a 5 in. diameter mirror is adequate.

The larger the mirror, the larger the radiating surface and consequently, the cooler it will run. A small mirror must reflect, just as much light, and just as much heat, as a large one, but, with a smaller surface, the heat cannot be radiated as rapidly.

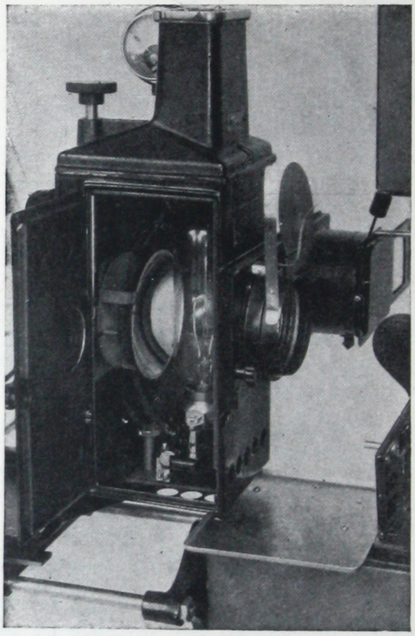

Fig. 10

One of the Latest Types of Housings. Note ammeter mounted on housing. This arrangement makes it convenient for the operator to determine the operating current at a glance

Secondly, means must be provided for the quick replacement of lamps, should one burn out while the picture is being projected. With an arc, the length of the carbon tells the operator how long his light will last. The Mazda lamp, however, may not give a full indication of when it is about to fail and, therefore, means must be provided for the quick substitution of a new lamp.

Means must also be provided for the ready adjustment of both mirror and lamp. Since MAZDA projection requires accurate work, the adjustment must be quite fine. In some housings, adjustment of the lamp must be made in the housing, after the lamp is inserted. A device recently introduced, however, enables the lamp to be prepared and accurately adjusted outside of the housing, and thus is in readiness for instant insertion, should the need arise.

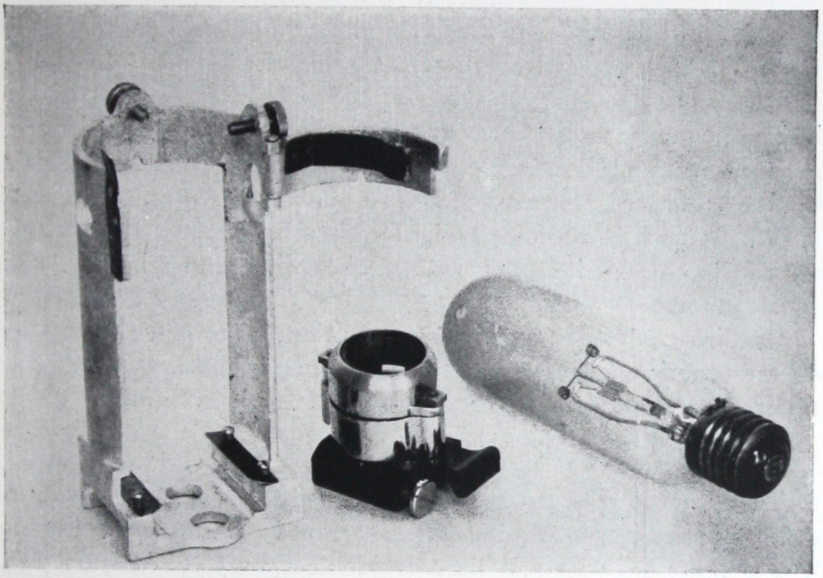

FIG. 11

A Lamp-setter, Lamp-socket and 900-watt Motion-picture Lamp. This lamp-socket does not embody a screw, but works on the ball-and-socket principle. When the lamp is accurately centered for the height, lateral and focus adjustments, the ball-and-socket joint is clamped, thus holding the lamp rigidly in place. By the aid of this device, a considerable number of lamps can be accurately adjusted during spare moments, ready for instant insertion in housing

Control Apparatus

The matter of current-control apparatus for MAZDA lamps is of the utmost importance. Good lamp performance demands a control which will not allow the lamp to be injured by over amperage. Several devices are on the market which answer this purpose. An ammeter is supplied to enable the projectionist to know when his lamp is at correct amperage.

MAZDA lamps operate equally well on direct current or alternating current. With alternating current, however, the control apparatus is greatly simplified and, therefore, MAZDA projection is best adapted to theaters equipped with alternating current.

Regulators are made both for 25 and 60 cycles. (Cycle refers to the number of alternations per second of the alternating current.) Sixty cycles is most common. They are also made for both 110 and 220 volts.

Alternating currents are controlled very simply, since the transformer principle is used. A transformer enables the voltage to be stepped up or down with very little loss of power. On direct current to step the voltage down, the usual method is to place a resistance in series.

For instance, to get 900 watts or 30 amperes at 30 volts from 110 volts alternating current requires, with the alternating-current regulators or transformer, a loss of only 90 watts. On direct current, however, where a straight resistance is used, to obtain 30 volts (30 amperes, i.e., 900 watts), 2400 watts must be wasted in the resistance.

On direct current for efficient operation, a motor-generator set, is best practice. When straight resistance is used, the reduction in current consumption over an arc projector is not great.

Accessories to Good Projection

To enable MAZDA projection to be used for long throws and the larger pictures, a reflecting type screen is recommended. The MAZDA lamp with its soft light is peculiarly adapted for use with such type of screens that throw a large amount of the projected light back, instead of spreading it, after the manner of a muslin sheet. A reflecting type screen is coming more and more into use where first-class projection is desired.

An ordinary painted muslin sheet presents a surface which is quite diffuse; that is, a light beam thrown upon it will be spread in practically all directions. With a reflecting type screen, the light beam is thrown to a greater or less degree directly back, in much the same way that a mirror throws back the light striking upon it.

If a house were only a few feet in width and the audience were directly in front of the screen, i.e., in line with the projection machine, a large mirror slightly frosted would serve fairly well for a screen. To spread the picture out, however, over a wide house means roughening, and changing the character of the surface of the screen, so that the light rays will be scattered, instead of coming directly back. A combination, therefore, of a mirror surface

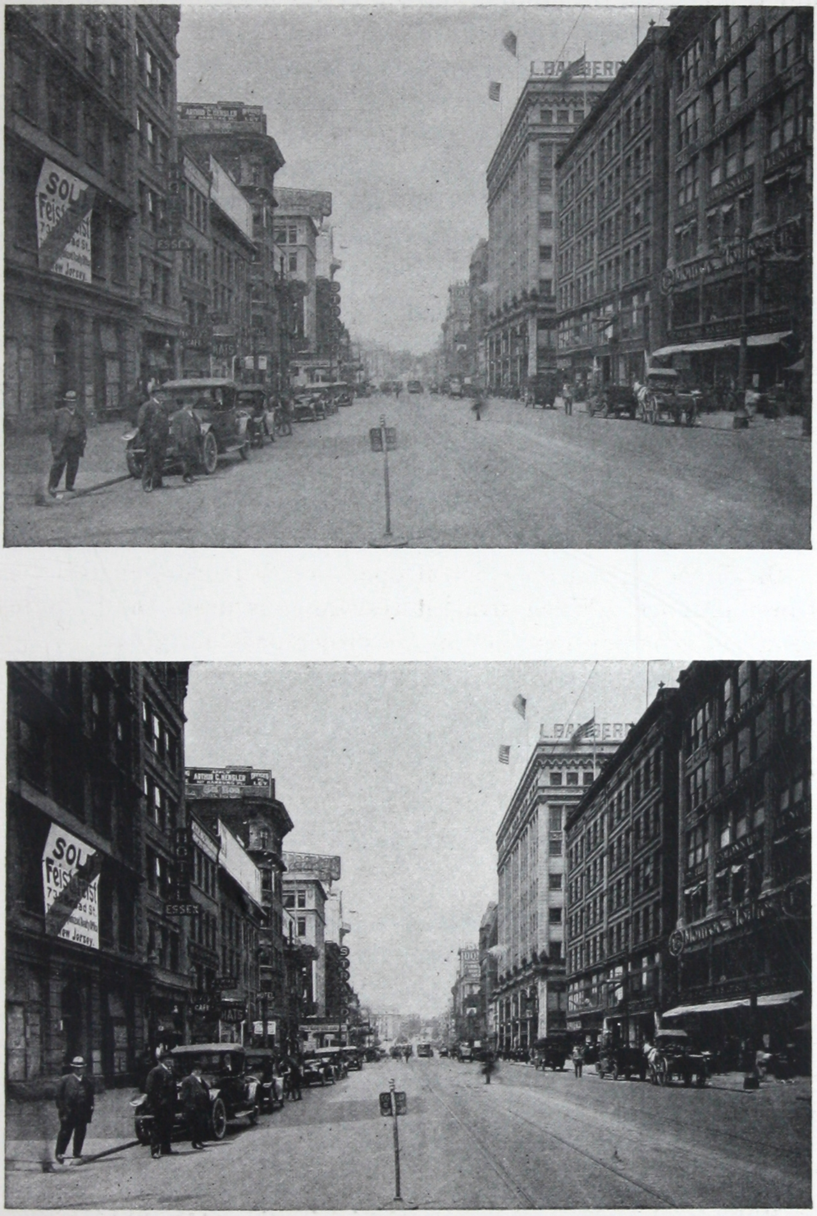

FIG. 12
These Two Views Approximately Illustrate the Effect Produced by Substituting a Prepared Screen for One of the Ordinary Type. The lower view indicates quite clearly the improvement in detail and contrast secured through the use of a prepared screen

and a scattering or diffuse surface is the most desirable, and is found in the prepared screens.

The matter of a projection lens is of equal importance. When the picture is taken, the camera lens used is the very best obtainable, costing perhaps six or eight times that of the ordinary projection lens. A film, then, taken with a good lens and projected with a poor one, will never give a first-class picture. A few extra dollars in lenses means, in the long run, money in the exhibitor's pocket.

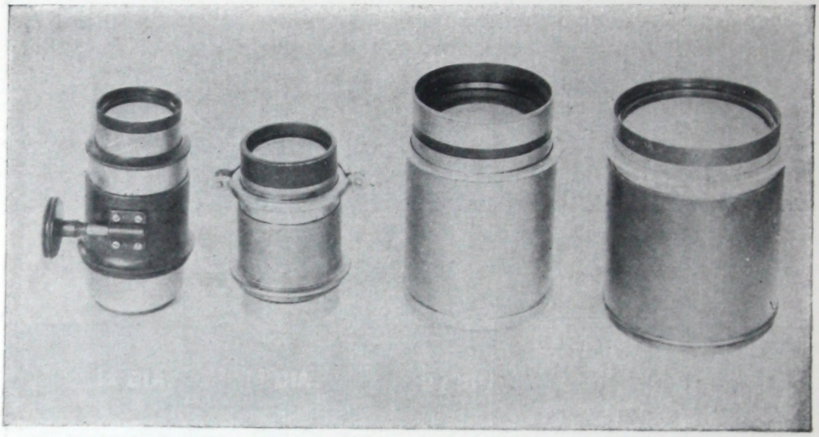

Fig. 13

Another Recent Design of Housing

With the Mazda lamp and the prismatic condenser, a No. 2 lens gives additional light on the screen. The following table shows the increase:

Diameter of Lens	Per cent Light
No. 1 lens, 1¾ in.	100%
No. 2 lens, 2½ in.	204%
3 in.	319%

(Lenses used in this test were 5½ in. focus.)

If, to refer again to our analogy of a stream of water, we were to place two drinking cups—one 1½ in. in diameter, and the other 2½ in. in diameter—under a faucet which was giving out water spread through a considerable angle, we would probably catch much more water in the 2½ in. cup. The same reasoning applies to the diameter of projection lenses.

Accurate focusing is a necessity with the MAZDA lamp. If your lamp, for instance, is only 1/8 off center, it means a 20 per cent decrease in light; and if the lamp is only 1/8 ahead of focus, it means a 23 per cent decrease in light.

It is practically impossible to tell, by the eye, when the most light is on the screen. Differences, however, are readily noticeable when a dark film is run through the projector. The following test shows how near the eye judges:

A light was thrown on a screen and several observers were asked to note its brightness. The light was thrown off for a few moments and another thrown on. Each observer claimed he saw no difference in the brightness of the screen although, in the first case, there was an intensity of four foot-candles and, in the second case, only two foot-candles. See (10).

Two lights of different quality were thrown, side by side, on the screen. The observers immediately placed one as being at least twice as bright as the other, and yet both were of the same intensity.

With the arc, where a three-winged shutter was formerly used, with MAZDA projection a two-winged shutter may be profitably employed. A two-winged shutter, of course, passes more light.

With the alternating current arc, the speed of the revolving shutter blade may often be exactly timed with the alternations of the current. When such is the case, the light on the screen will vary periodically in intensity.

Operation

The operation of the MAZDA lamp, when the optical system is properly lined up and the lamp focused, is extremely simple—the strongest appeal to the projectionist. No one cares to keep continually fussing with adjustments such as are necessary in feeding a non-automatic arc. Focusing with the MAZDA lamp, however, is slightly more complicated than with the arc, since two images—one of the filament, and the other of the mirror—have to be contended with.

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10. The term "foot-candle" is used to measure the intensity, or the pressure, or the thickness of the light at a certain point. A foot-candle is a measure of the intensity of light at a certain point, just as a pound of steam is the measure of the pressure of steam at a certain place. Measuring the intensity of light on a screen, as foot-candles, is as simple as measuring the temperature of a bucket of water, with a thermometer, as so many degrees. "Foot-candle Meters" are obtainable from various lamp manufacturers.

The images may be allowed to fall upon the blade of the revolving shutter. Shutter, of course, must be properly positioned. The lamp is then moved forward and back until the filament stands clearly defined upon the revolving shutter blade. The mirror is then focused in the same way, and its images fitted in between those of the filament coils.

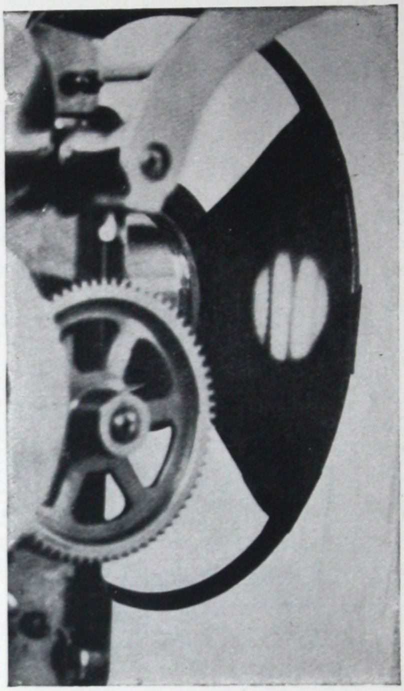

Fig. 14
The Filament Image Properly Focused and Symmetrically Placed on revolving Shutter

A pin hole in the dowser on some housings allows a sharp image of the filament and the mirror reflection to fall upon the fire shutter or cooling-plate, so that a ready check upon the correct focus and placing of mirror may be had.

When used for stereopticon projection, a set of plano lenses are easily pulled into place. The prismatic lens (as before described) cannot be used for stereopticon work.

As regards operation of the lamp, itself. When it has burned approximately 100 hours, there may be noticed on the surface of the filament very minute holes, much the same as those in a sponge, only, of course, very much smaller. This is called "spot evaporation" and is an indication that the filament has burned its rated life, and that a new lamp should be inserted.

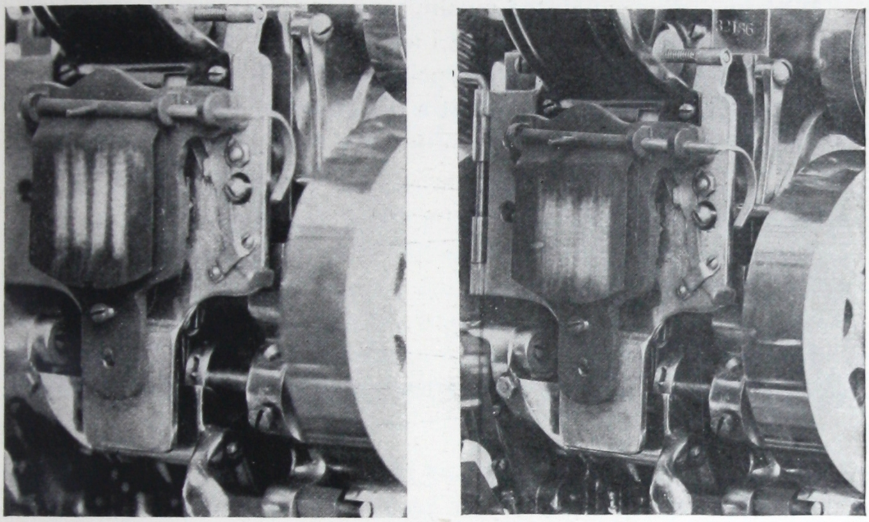

FIG. 15

Method of Setting Image Thrown by Mirror, with Reference to Filament. The view at the left shows the image produced from the filament alone. The one at the right shows the spaces between sections of filament filled by the reflected image, giving a practically uniform light source. A pinhole in the dowser causes the production of these images

Again, the four filament coils should at all times be equally spaced. If, for any reason, the coils should bend toward each other so that they are about to touch, the lamp should be removed, since, if one coil touches an adjoining one, a short circuit will result, and the lamp will burn out.

The lamp should be inspected before each run. Mirror and condenser should be thoroughly cleaned each day.

Field of the Mazda Lamp for Motion-picture Projection

The 30-volt, 30-ampere, 900-watt, motion-picture lamp with prismatic condenser and mirror will replace any alternating-current carbon arc, no matter how skilfully handled. On direct current it will replace arcs up to 25 amperes, and even arcs of higher amperages, where those arcs are at present not properly manipulated.

With an ordinary painted muslin screen or plaster wall, a 12-foot picture can be obtained on throws not exceeding 80 feet.

With a first-class reflecting type-screen, a 15- to 16-foot picture may be satisfactorily projected at a distance not exceeding 90 feet.

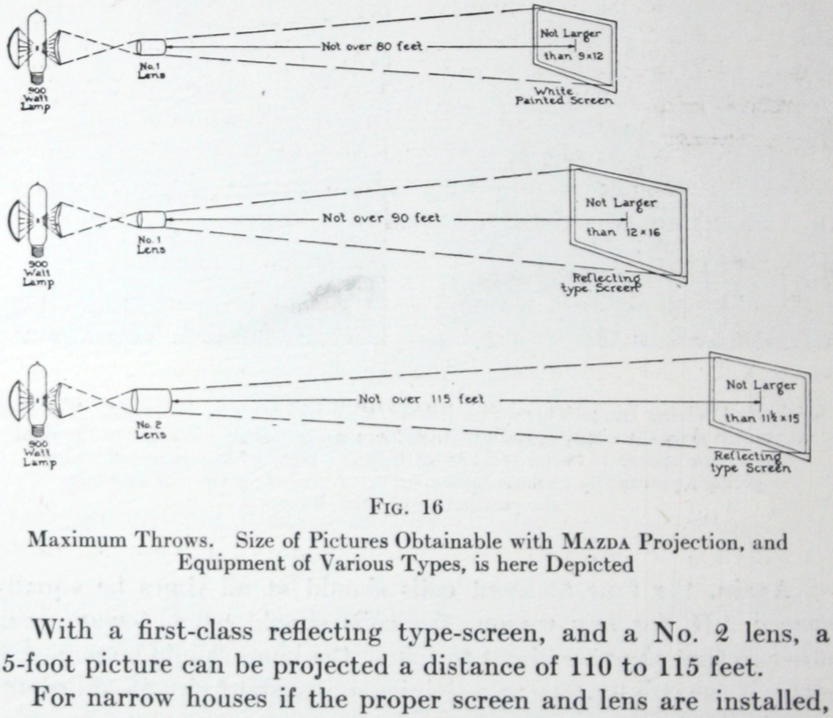

FIG. 16

Maximum Throws. Size of Pictures Obtainable with MAZDA Projection, and Equipment of Various Types, is here Depicted

With a first-class reflecting type-screen, and a No. 2 lens, a 15-foot picture can be projected a distance of 110 to 115 feet.

For narrow houses if the proper screen and lens are installed, longer throws can be obtained. It must be remembered that first-class results cannot be obtained unless lamp and mirror are accurately focused and lamp is properly operated.

A smaller size MAZDA lamp for motion-picture projection—the 30-volt, 20-ampere, 600-watt lamp—is about three-quarters as powerful as the 900-watt, 30-ampere lamp. The construction and appearance of the two are identical. The same size bulb is used for both, and the only difference lies in the size of the filament wire.

The 600-watt lamp, of course, is not as powerful as the 900-watt and was not designed for large motion-picture work, but more to fill the need for small theaters, churches, schools, small auditoriums and halls.

Again, often in a small town, where there is only a limited supply of current, or where a theater makes its own power, the 900-watt lamp may be too great a drain on the current supply.

Both the 900- and 600-watt lamps run at approximately 30 volts, and thus can be run from the 32-volt country home-lighting outfits, providing proper rheostats be used to insure the lamp operating at exact amperage.

There are now on the market several types of small portable motion-picture machines that will fit into a suit case, and are used by salesmen, lecturers, etc., or for parlor entertaining. For this class of work, where the picture is necessarily small, and the throw comparatively short, a low-voltage lamp is not an absolute necessity. Such machines are usually equipped with 110- to 115-volt stereopticon lamps.

A 400-watt lamp in a round bulb is usually used. The round bulb is more compact, but it does not allow the lamp to be placed as close to the condenser. Consequently, the amount of light picked up is decreased over that which could be obtained from a lamp in a tubular bulb and a condensing lens designed for a short back focus.

There has recently been developed a small, low-wattage, low-voltage lamp for use with small, portable motion-picture machines. It takes only 100 watts, is of 25 volts, and four amperes and, when used with the proper condensing lens system, will put more light on the screen, than a 400-watt, 110-volt stereopticon lamp used for this purpose. The increased light that is obtained is due to the fact that the lamp is placed in a very small tubular bulb, and the bulb is placed very close to a specially designed condenser; thus, a large angle of light is picked up.

For slide projection in a commercial motion-picture theater, a 1000-watt, 110-volt lamp is available. The standard 110-volt lamp is well adapted for this sort of work, since the projection of slides does not require such a high intensity as is necessitated with film.

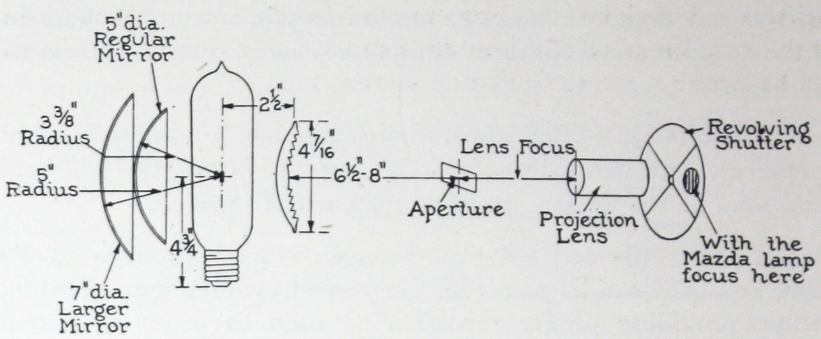

FIG. 17

The Optical Set-up of the MAZDA Motion-picture Train. Dimensions of component parts and their relations are indicated

Summary

Edison MAZDA lamps for motion-picture projection, if properly operated, will give the following results:

1. The screen will be kept bright all of the time. Such a condition is impossible with the arc, because the arc is bound to wander. Practically, however, the filament of the incandescent lamp, stays where it is put.

2. The light will not need constant attention. With the arc, keeping the spot on the aperture, and in focus, means constant watching and continual manipulating. When a MAZDA lamp, however, is once accurately set, there should be little need for further adjustment until a new lamp is inserted.

This does not mean, however, that the lamp can be forgotten. There are certain precautions always necessary to be observed with the MAZDA lamp.

3. There will be less heat in the booth. The amount of heat is almost in proportion to the number of watts. Therefore, a carbon arc using up 3000 watts in the arc and 800 watts in the control, a total of 3800 watts, would develop four times as much heat as a MAZDA lamp burning only 900 watts, plus a control loss of 90 watts.

4. There will be no carbon dust to scratch the film or wear out the bearings. All gaseous vapors, which have been proven injurious to health, will be eliminated.

5. Many motion-picture theaters are purchasing current at lighting rates of 6-8-10¢. per kilowatt-hour. The following table gives an estimate of the saving that may be expected by the use of the Edison Mazda C Motion-picture Lamp:

ARC LAMP		MAZDA LAMP	SAVING PER YEAR (3650 Hours) in Operation of Mazda lamps at		
Amperes at Arc	Wattage of Arc and Control Equipment	Wattage of Lamp and Control Equipment	10c. Kw-hr.	8c. Kw-hr.	6c. Kw-hr.
ARC CONTROL-RHEOSTAT					
25	2750	990	$624.00	$496.00	$366.00
30	3300	990	824.00	656.00	487.00
35	3850	990	1025.00	824.00	608.00
40	4400	990	1226.00	977.00	747.00
45	4950	990	1427.00	1138.00	867.00
50	5500	990	1628.00	1298.00	988.00
55	6050	990	1828.00	1459.00	1108.00
60	6600	990	2029.00	1620.00	1232.00
ARC CONTROL—MOTOR-GENERATOR, COMPENSATOR, OR RECTIFIER					
25	1625	990	$213.00	$167.00	$139.00
30	1950	990	332.00	262.00	210.00
35	2275	990	451.00	357.00	281.00
40	2600	990	569.00	452.00	354.00
45	2825	990	688.00	547.00	424.00
50	3250	990	807.00	641.00	495.00
55	3757	990	982.00	789.00	588.00
60	3900	990	1044.00	831.00	637.00

Based on a lamp cost of $.06 per hour and a carbon cost of $.05 per hour.

6. Flicker will be materially reduced.

7. The picture will be soft and pleasing to the eye. Many people are of the opinion that all that is needed in motion-picture projection is plenty of light. Such, however, is not the case. Of course, there must be sufficient light, but the addition of too much light kills detail in the picture, and makes the screen dazzling to the eyes of the audience.

After all, what the audience desires is a picture that is easy on the eyes, and in which detail is paramount. Detail is a function, both of the amount and the quality of the light. In other words, it is possible, if the light is of the correct quality—i.e., of the correct color value—to produce a better picture with a small amount of light, than can be done by piling on the screen indiscriminately all the light the projectionist can, by high amperage, muster.

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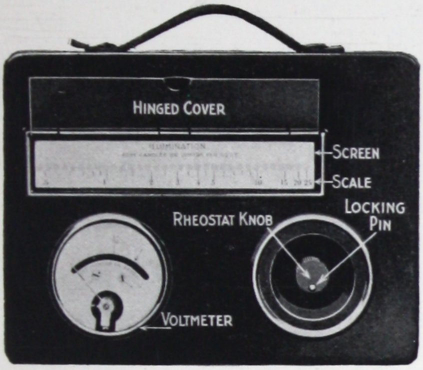

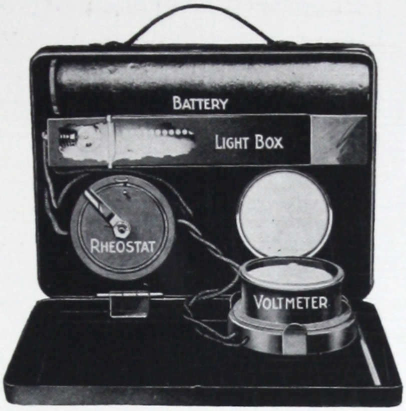

The Foot-candle Meter is a very simple and compact portable photometer, selling at the low price of $25.00. The Foot-candle Meter proves very useful in connection with motion-picture projection in checking the intensity of light on the screen. It can be placed at different points and the average intensity calculated from the individual readings. The usual method of operation is to divide the screen into 12 or 16 equal areas and read the foot-candle intensity at the center of each area. Thus, if we know that a certain installation gives a first-class projected picture it may be of interest to know just how much light is actually on the screen so that if changes are made in the apparatus the projectionist can measure the actual increase or decrease in the intensity of light.

The Foot-candle Meter is as simple in use as a thermometer, a water pressure or steam gauge. The scale is direct reading, and the only adjustment necessary is that of the rheostat to bring the standard lamp to the correct voltage.

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